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Bitten by a Poisonous Snake? Why We Can't Be Sure Yet

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The role of poisonous snakes in predator-prey relationships is an area which is often misunderstood and is currently understudied. Different mechanisms exist that enable snake species to become poisonous, but all known poisonous species hold two basic unifying characteristics. All acquire their poison from amphibian prey they consume, and all have been shown to benefit from sequestering that poison by subsequently becoming poisonous to their predators (Brodie et al., 2002). While the presence of poisons in snakes has been documented since 1935, the mechanisms have only recently been uncovered (e.g., Azuma et al., 1986). Recent research suggests there might be more poisonous snakes than previously thought. Most of these snakes have been described as species, but have not yet been confirmed as poisonous species (Williams et al., 2004). This paper aims to explain the current knowledge on the topic of poisonous snakes and sets to identify research gaps that, if filled, could lead to uncovering more poisonous species, as well as understanding evolutionary origins and potential future paths in changing environments.

While the primary focus of this discussion is to outline the mechanisms behind poison sequestering in snakes for predator defense, many of the snakes discussed also have venom, which can be used to subdue their prey, or some toxic substance they expel as a deterrent (later to be defined as a *toxungen*). While each term describes substances with similar end results for organisms exposed, the functions, methods of delivery and purposes can be vastly different. For consistency, Nelsen et al. (2014) will be used as the model text in defining toxins, poisons, venoms and toxungens.

Toxin is the most encompassing term; however, Nelsen et al. (2014) note in their literature review that there has been little uniformity in its usage. They argue toxins are simply "substances that, when present in biologically relevant quantities, cause dose-dependent pathophysiological injury to a living organism, thereby reducing functionality or viability of the organism." Any substance could be classified as a "toxin," but the level of toxicity is highly dose dependent. For example, water could be classified as a toxin, but the dose required to be toxic in most organisms is substantially higher than the toxic dose of cyanide (another toxin), or any snake venoms (substances composed of multiple toxins). This is an important baseline for agreement in further classifying various toxic substances and an organism's method of storage and delivery.

Poison and poisonous are two terms often misused interchangeably with the terms venom and venomous (Nelsen et al., 2014). A poison is "a toxic substance (comprised of one or more toxins) causing dose-dependent physiological injury that results in self-induced toxicity (e.g., bacterial endotoxins) or is passively transferred without a delivery mechanism from one organism to the internal milieu of another organism without mechanical injury, usually through ingestion, inhalation, or absorption across the body surface" (Nelsen et al., 2014). In a broad sense, poisons are used primarily to deter or harm a predator; while, in contrast, venom is primarily used to facilitate the subduing of prey (Nelsen et al., 2014). In most cases, the threatening organism must come into immediate contact with the poison via ingestion or absorption for it to be effective, which is why this method of toxin delivery is often coupled with evolutionary adaptations to "warn" potential threats these toxins are present (Nelsen et al., 2014). Bright aposematic coloration and defensive postures indicating toxicity can prove crucial to the individuals possessing the poison because they ultimately receive no benefit from these substances if they are killed during the delivery (Savitsky et al., 2012).

Some previous definitions of venom specifically defined the delivery mechanism as injection; however, this would exclude some significantly venomous species like Gila monsters (*Heloderma suspectum*) and beaded lizards (*H. horridum*), which lack hollow dentition for injecting. Also, in these lizards the venom gland is located in the lower maxillary, so they must "chew" and work against gravity to deliver their prey-subduing venom. Snakes in the genus *Rhabdophis* are highly toxic colubrids that have aglyphous dentition (lacking grooves or hollow syringe structure), but their bites have caused severe human injury (Smeets et al., 1991). To accurately define venom to include these species, which the majority of scientific authors have considered venomous, Nelsen et al. (2014) defined venom as "a toxic substance (comprised of one or more toxins) causing dose-dependent physiological injury that is passively or actively transferred from one organism to the internal milieu of another organism *via* a delivery mechanism and mechanical injury."

A method of toxin delivery that does not fit any current or past definitions described involves the secretion of a toxin, usually in defense, without first causing an open mechanical injury to the potential threat or requiring the delivering organism (or part of the organism) to be consumed (Nelsen et al., 2014). Spitting cobras (*Naja* and *Hemachatus* spp.) are well known to expel venom multiple yards toward the eyes of threats in an attempt to deter them. While this usually requires contact with a mucous membrane to be irritating, some organisms can be highly sensitive to these toxins through skin contact alone (Nelsen et al., 2014). To accurately describe a method of toxin delivery used by spitting cobras and many other animals to deter their predators, Nelsen et al. (2014) have chosen to employ the new term "toxungen," which they describe as "a toxic substance (comprised of one or more toxins) causing dose-dependent physiological injury that is actively transferred *via* a delivery mechanism from one organism to the external surface of another organism without mechanical injury."

To further clarify the defining characteristics of poisons, toxungens and venoms, Nelsen et al. (2014) proposed a binomial classification scheme be used to outline the delivery and storage of toxic substances based on the presence or absence of glands and whether an organism produces its own toxins, or if

they must be obtained from another source. The four major classes proposed by Nelsen et al. (2014) will be explained here using the term poisonous, but the same system is applicable to venoms and toxungens. *Autoaglandular–poisonous* describes organisms that produce their own toxins, do not store them in specialized glands, and do not actively deliver the toxin via mechanical injury or projection. Many plants and fungi are perhaps the best example for this classification. They do not actively seek out their food source, nor do they have glands. However, if the plants absorb toxins (such as heavy metals) from the soil in which they are growing, they are not producing their own toxins nor storing them in specialized glands, so they would be considered *heteroaglandular–poisonous*.

Autoglandular–poisonous describes organisms that produce their own toxins and are able to store the toxins in specialized glands. Amphibians are a prime example of this, with nearly all having the ability to produce varying degrees of toxins secreted through granular glands. Although amphibians in the family Dendrobatidae possess granular glands that undoubtedly produce a small level of toxin on their own, it is insignificant in comparison to the highly toxic substances derived from their diet. As a result, dendrobatid frogs would be described as *heteroglandular–poisonous*.

In 2014, the first case was reported on toxin ophthalmia caused by the nuchal gland poison in *Rhabdophis tigrinus* (Chen et al., 2014). The snake sprayed its poison from its neck into the eyes of a 40-year-old man, and he was hospitalized with progressive burning and blurred vision (Chen et al., 2014). This case makes clear some *Rhabdophis* are not only autoglandular–venomous when they bite—and heteroglandular–poisonous when predators ingest the poison from their neck derived from an anuran diet—but also heteroglandular–toxungenous when they squirt this poison (toxungen in this instance) onto the face and eyes of their threats (Nelsen et al., 2014).

Nakamura (1935) outlined in detail the presence of poison glands in *Rhabdophis*, showing that up to 15 pairs of integumental glands occur in the nuchal (neck) region of *Rhabdophis tigrinus* (as *Natrix tigrina*). The poison was described as a necrobiotic, neutral, crystalline and granular fluid that causes severe irritation of the mucous membranes when mechanical pressure is applied to the skin surface (Nakamura, 1935). The mechanical pressure was subsequently discovered to not be necessary to release this toxin, as noted above in the case reported by Chen et al. (2014). The poison from these glands also has been found to be chemically comparable to cardiac steroids found in toads, and is believed to be acquired from a toad-rich diet (Mori and Burghardt, 2000). The nuchal glands have been noted to lack secretory epithelia and organelles and instead have a dense capillary network (Hutchinson et al., 2007). This suggests the cardiac steroids, or bufadienolides, are transported via the plasma and not manufactured in the glands directly, and tests comparing samples of *R. tigrinus* with toad-rich diets compared to those lacking a toad diet confirmed this suggestion (Hutchinson et al., 2007). By this understood mechanism, these *Rhabdophis* are therefore heteroglandular–poisonous. Bufadienolides act by inhibiting the voltage-gated sodium potassium pump (Melero, 2000). In snakes sequestering them, they are structurally identical to bufotoxins in toads, except they are missing a side chain containing the amino groups (see Hutchinson et al., 2007: Figures 2 and 5). It is believed this side chain is lost by hydroxylation subsequent to uptake, and further study is needed to confirm whether this serves to increase potency, but similar hydroxylation has been demonstrated to dramatically increase toxicity of an alkaloid sequestered by dendrobatid frogs (Hutchinson et al., 2007).

When threatened, some *Rhabdophis* will tilt their head down and arch their neck exposing the usually bright-colored nuchal region, which often contains the poison glands described above (Mori and Burghardt, 2000). Snakes from islands lacking toads were found to exhibit this behavior less often than snakes from toad-rich regions (Mori and Burghardt, 2000). However, those tests were conducted before it was found that the act of arching their poisonous nuchal region appeared to be more prevalent at low temperatures, whereas at higher temperatures, the snakes were more likely to attempt escape (Mori and Burghardt, 2001). Without controlling for temperature, it is difficult to characterize the relationship between defensive posture and toad presence (Mori and Burghardt, 2001). In addition to odd defensive postures, *R. tigrinus* also exhibit an unusual prey consumption technique hypothesized to be specific for anuran diets (Mori, 2006). Studies in Australia have shown some snakes with smaller heads to have higher fitness (Phillips and Shine, 2004). It is believed that larger gapes, which allow the snakes to ingest larger (and subsequently more toxic) toads, are directly linked to their chance of mortality (Phillips and Shine, 2004). With a snake that has adapted to the high amounts of toxins in its anuran diet, which also serves an evolutionary benefit when they can sequester those toxins for their own defense, a behavioral change to maximize their potential prey size is advantageous (Mori, 2006).

Rhabdophis tigrinus and *R. subminiatus* are the species most commonly observed, but *R. murudensis* is an uncommon and minimally studied montane natricine species that also has been reported to exhibit many of the same defensive postures related to their poisonous nuchal glands (Stuebing and Tan, 2002). To show the presence of poisonous nuchal glands has a direct link to the defensive postures seen in these natricine snakes, Mori and Burghardt (2008) conducted tests on both New and Old World snakes, some with nuchal glands and some without. They noted that earlier negative test results also should be examined carefully because the relationship to temperature was not controlled for in all previous studies examining those postures (Mori and Burghardt, 2008). *Rhabdophis adleri*, *R. chrysargos*, *R. spilogaster*, *R. swinhonis* and *Macropisthodon rudis* have not been found to have nuchal glands (Mori et al., 2012), so to best understand the evolutionary relationship of this trait, these species should be a primary testing choice. Tekeuchi and Mori (2012) later showed *M. rudis* did not exhibit all the same postures as the species containing nuchal glands, but similar conclusions still await for the four *Rhabdophis* species.

Since *Rhabdophis* do not make their own toxins and rely on sequestering from bufotoxins in their diet, it might be expected that hatchling snakes would be nonpoisonous, just as snakes feeding on diets lacking toxic toads would be nonpoisonous.

When samples of hatchling animals from islands absent of toads were compared to hatchlings from areas where toads were present, it was discovered snakes from the toad-present regions had bufadienolide toxins at birth, and snakes from toad-absent areas only acquired toxins after being fed toads (Hutchinson et al., 2005). This finding immediately suggested maternal provisioning of the toxins, and subsequent study demonstrated gravid mothers are indeed able to pass on toxins to their offspring before oviposition (Hutchinson et al., 2008). Dietary contents of radio-tracked females showed they actively foraged for toads in their habitat when they were gravid in an attempt to arm their offspring with poisons upon hatching (Kojima and Mori, 2014). In viviparous snakes, it might be expected mothers could pass these toxins to their developing young because a vascular connection is maintained throughout gestation. However, in the oviparous species *R. tigrinus*, mothers must rapidly stock poisons to provision in the yolk before oviposition for embryos to take up later in development (Kojima and Mori, 2014). Y-maze experiments also confirmed gravid females were more likely to seek toads compared to males and nongravid females (Kojima and Mori, 2014).

Very little has been published on two Asian genera, *Macropisthodon* and *Balanophis*, which are closely related to *Rhabdophis* and have the same dorso-nuchal glands (Smith, 1938). Aside from the cataloging of their existence, the only studies involving any of the five species within these two genera have been on venom (Fry et al., 2008), prey accounts (Biswas and Acharjyo, 1975), a breeding observation (Hans and Wang, 2013), and one behavioral study on *Macropisthodon rudis*, the only species of *Macropisthodon* that lacks the poisonous nuchal glands (Tekeuchi and Mori, 2012). In a paper examining the evolutionary origins of venom, Fry et al. (2008) detail that *Macropisthodon* has isolated mucoid cells or patches, a relatively large ovate duct, a vestibule present and adjacent to the fang sheath, and the venom duct opens only to the oral cavity, which is consistent with *Rhabdophis* and many other natricine snakes, but further detail on these genera is not provided. These qualities reveal *Macropisthodon* (and all natricines) as being examples of autoglandular–venomous snakes. In 2014, a bite from *Balanophis ceylonensis* was documented for the first time in English, and the effects to a 33-year-old field biologist were incredibly severe (Fernando et al., 2015). The authors recognize this species to be medically significant and call for further venom studies on colubrid snakes as a result. Such a severe outcome with the first documented bite suggests human encounters with this species are very low, and this might be why no studies have been conducted on the single species in this genus. Tekeuchi and Mori (2012) use the reluctance of the toad-eating species *M. rudis* to display defensive postures seen in similar species that possess nuchal glands as evidence to support that toad preference pre-dates the evolution of nuchal glands, and that defensive postures were a later adaptation. However, they do not examine possible sequestering abilities of this snake in aglandular tissues, including the skin in the nuchal region, to identify a possible evolutionary link. Readers of this paragraph should consider they are now as familiar with all species of *Macropisthodon* and *Balanophis* as any scientist reviewing these genera and thus recognize a reasonable call for further investigation of these species to understand the evolution of poison sequestering and its role in an ecosystem.

To sequester toxins and subsequently be poisonous to potential threats, an organism must first be able to uptake those toxins, develop resistance and survive the process (Williams et al., 2003). Snakes in the genus *Thamnophis* exhibit varying levels of resistance to one toxin in their potential diet based on their range (Geffeney et al., 2002). In areas absent of newts in the genus *Taricha* carrying tetrodotoxin, or TTX (once tarichatoxin), tests show *Thamnophis sirtalis* exhibit limited resistance to the toxin. But in areas where *Taricha* are prevalent and a primary food item for local *T. sirtalis*, those snakes show up to 100 times the TTX resistance levels exhibited by other *Thamnophis* (Brodie et al., 2002). However, studies also have shown snakes in the genus *Thamnophis*, as well as other closely related natricine snakes, tend to be 10 times more resistant to TTX than colubrid snakes in other subfamilies (Motychak et al., 1999). This might suggest an evolutionary predisposition to TTX resistance (Brodie et al., 2002), which could fall along similar lines as *Macropisthodon* studies that indicated a toxic amphibian diet pre-dates the evolution of toxin sequestering glands (Tekeuchi and Mori, 2012). While it might seem obvious a diet including a toxin would pre-date further resistance to the toxin, it is an important step to consider before analyzing the function of sequestering these toxins at a level poisonous to common predators.

An evolutionary arms race between the toxicity of *Thamnophis* and *Taricha* led to populations of *T. sirtalis* becoming highly resistant to TTX secreted by *Taricha*, which caused both the predator and prey to become more toxic over time (Brodie et al., 2005). This high resistance also has resulted in *T. sirtalis* being armed with a toxin that is highly poisonous to their predators (Williams et al., 2004). A precise dataset for the toxicity of TTX on avians (globally common snake predators) does not exist, but best estimations indicate the lethal dose to be 46 μg/kg (Williams et al., 2004). In a population consisting of highly toxic newts and highly resistant snakes, the average amount of TTX found in the livers of snakes after three weeks was 42 μg (Williams et al., 2004). To put this in perspective, red-tail hawks are one of the largest birds of prey in North America, with an average size of 1080 g, or ~1 kg. All of the other avian predators in this area are closer to half that size, which means having eaten one newt could render a garter snake lethally poisonous to most of their predators for roughly a month. Snakes tested that had been on a more regular or more recent newt diet were found to have livers with more than twice the TTX quantity (Williams et al., 2004). Based on personal communication with M. Pfrender and R. Mason, R. Shine mentions live *Thamnophis* were seen with ventral scars they believed were from partial liver removal during attacks from birds (Shine et al., 2001). The liver is easily located by intelligent birds like crows, and it is a highly nutritious organ in snakes (Shine et al., 2001). In Manitoba, where *T. granulosa* does not occur, crows were found to be the main predators of emerging snakes, and they specifically excised their livers (Shine et al., 2001). This could prove a fatal behavioral trait in regions where *Thamnophis* prey on *Taricha* species, as the sequestering of toxins in their liver makes them heteroaglandular–poisonous. Individuals of the highly toxic Benton

County, Oregon, population of *T. sirtalis* are vividly colored and flatten their bodies to warn predators (Williams et al., 2004).

Based on evolutionary similarities in physical structure or dietary preferences, it is unlikely the only poisonous snakes are the nuchal-gland-possessing *Rhabdophis*, *Macropisthodon* and *Balanophis* species and the toxin-sequestering *Thamnophis* species. Studies on the genera known to possess poisonous nuchal glands have not looked at sequestering of toxins in other tissues and organs as have the studies done on *Thamnophis*, but it is certain all species have a liver, so they should have the same, or similar, abilities as *Thamnophis* to store toxins there. However, it might be interesting to compare levels of bufadienolides in the liver and other tissues in anurophagous snakes with nuchal glands, and compare them with levels in snakes from the same genus that lack nuchal glands. *Thamnophis* test subjects on a diet of *Taricha* showed high amounts of TTX (~60 μg) present in the liver up to 7 weeks after being switched to a diet of fish (Williams et al., 2004). TTX also was present in the kidneys up to 3 weeks, but it was no longer found in skeletal muscle, cardiac muscle, or the blood beyond one week after consuming newts (Williams et al., 2004). Epidermal skin samples have not been tested. One reason snakes can function normally with high levels of TTX in their system for long periods of time is they do not need to expel it, as it is sequestered primarily in the liver, away from the sites of action in voltage-gated sodium channels (Williams et al., 2004). Similar action would likely be the case in epidermal tissues, and particularly in specialized glands. Skin would, by default, be the first point of contact a predator would have with its prey, so if there is a mechanism that allows for uptake and sequestering in these tissues, it would make the most evolutionary sense for this to occur. Knowing the presence of nuchal glands in the epidermal layer, it would seem logical to test these tissues in species of *Rhabdophis* and *Macropisthodon* where the glands are lacking, to possibly uncover an evolutionary origin of the glands. Geographically distant natricine snakes like *Thamnophis* also should be tested.

It has long been known that *Tropidonophis mairii* can consume highly toxic amphibians other squamates tend to avoid (Madsen and Shine, 1994). However, no research has been conducted examining whether they can sequester poisons from their prey and possibly secrete them, though Dr. Bryan Fry suggests this is an area that might be soon examined (B. Fry, pers. comm., 2015). Natricine snakes have been the exclusive species of study so far in regard to poisonous snakes. Aside from other Asian natricines closely related to *Rhabdophis*, *Macropisthodon* and *Balanophis*, the only Australian natricine, *Tropidonophis mairii*, a species moderately well studied on its ability to handle large uptake of toxins and now including bufotoxins due to invasive species, is a strong candidate for examination.

In Australia, *Tropidonophis mairii* has been a snake of particular research interest due to its unique ability among native snakes to consume the invasive cane toad, *Rhinella marina* (formerly *Bufo marinus*). When other snakes and reptiles consume *Rhinella marina*, it often proves fatal, and while the invasive prey is not as nutritious as some of the anurans it has displaced, a competitive advantage is granted to *T. mairii* in that it is able to consume this food source with minimal adverse effects (Llewelyn et al., 2009). The ability of *T. mairii* to consume toxic anurans was not an attribute awarded to this snake upon the arrival of the invasive toads. *Litoria dahlii* is a native frog in the Australian tropical floodplains that has proven lethally poisonous to even large snakes such as pythons (Madsen and Shine, 1994). *Tropidophis mairii* is known to consume *L. dahlii* regularly and is not harmed by this frog that is avoided by other snakes (Madsen and Shine, 1994). It is not the exclusive serpentine predator of native toxic anurans, but it is does seem to be uniquely capable of handling invasive toads with minimal adversity (Llewelyn et al., 2011). Red-bellied blacksnakes, *Pseudechis porphyriacus*, are heavily anurophagous elapid snakes that appear to have undergone morphological changes due to selection consequences from *Rhinella* consumption (Phillips and Shine, 2004). Their inability to handle high amounts of the bufotoxins has resulted in snakes with smaller ratios of head size to body mass being more abundant. The presence of a larger gape that can accommodate larger toads is directly related to the chance of mortality for that snake, thus reducing its chance at proliferating (Phillips and Shine, 2004). A similar reduction in the ratio of head size to body mass was observed with the arboreal, and also anurophagous, snake *Dendrelaphis punctulatus* (Phillips and Shine, 2004), but it might be moderately expected, as this species also exhibited strong sensitivity to toxins from the native *Litoria* frogs (Madsen and Shine, 1994).

Snakes from populations prior to arrival of invasive *Rhinella* were tested and compared with snakes that have had some evolutionary time to adapt, and results indicated *T. mairii* from both populations exhibited similarly high tolerances to the toads and their bufotoxins (Llewelyn et al., 2011). Snakes from both populations also showed no indication of learned behavior to avoid the toads once exposed, despite no bufonids existing in Australia (Llewelyn et al., 2011). These combined qualities suggest the abilities of *T. mairii* to deal with toad consumption is an ancestral trait (Llewelyn et al., 2011). The genus *Tropidonophis* is a more recent arrival to Australia than other snakes (Llewelyn et al., 2011). It is the only Australian representative of the subfamily Natricinae, and its ancestors migrated from Asia in the Pleistocene or late Miocene (Cogger and Heatwole, 1981). In Asia, natricine snakes were, and still are, exposed to bufonids regularly (Malnate and Underwood, 1988). Studies by Llewelyn et al. (2011) showed how evolutionary origin could give insight to how species might adapt to invasive species, but this might also provide an indication that could lead researchers to another poisonous snake being revealed through a toad diet.

Natricine snakes have been the exclusive species of study for poisonous snakes largely because the snakes containing the poison sequestering nuchal glands have all been natricines. Apart from the aforementioned three Asian genera, only one other poisonous genus, *Thamnophis*, has been examined for its poison sequestering capabilities. The mechanism of rendering some snakes in this genus poisonous to their potential predators has been storing tetrodotoxins in organs and tissues, primarily the liver, and not in specialized glands (McGlothlin et al., 2014). All snakes have a liver, so the correlation of *Thamnophis* also being a natricine snake might only be a coincidence. If the close

relation on a subfamily or family level is momentarily dismissed in an attempt to reveal more distantly related poisonous snakes, *Thamnophis* can be used as a model to cross-examine snakes occupying similar ecological niches. *Thamnophis* was found to possess resistance to tetrodotoxins in much higher levels than other North American colubrid snake. Is it just a coincidence they are the North American colubrid genus which fills the niche of consuming more toxic wetland amphibians? Bufotoxins and bufadienolides were shown to be the primary source of poison sequestering in Old World snakes, and these toxins also exist in the New World (Hutchinson et al., 2012). However, sequestering of these toxins in organs and tissues has already been recognized as a research gap in the Old World, so it would seem appropriate to examine any snakes with diets rich in bufotoxins to see if the capabilities seen in potent tetrodotoxins also function with bufoxins or bufadienolides in making snakes poisonous to potential threats.

Geographically isolated from the above-mentioned western populations of TTX-resistant *Thamnophis*, a population of *Agkistrodon piscivorus* in South Carolina has been documented as having a diet rich in *Ambystoma talpoideum*, a moderately large species of salamander known to excrete significant amounts of bufotoxin from its paratoid glands (Eskew et al., 2009). In a study examining ambush site selection comparing juvenile and adult cottonmouth snakes, *Agkistrodon piscivorus*, Eskew et al. (2009) found juvenile snakes consume a diet almost exclusively of amphibians, and 68% of juvenile snakes consumed predominantly *Ambystoma talpoideum*. It was not until nearing adulthood that snakes ate anything but amphibian prey; into adulthood they underwent a shift in diet to mostly snakes and birds (see Eskew et al., 2009: Figure 6). Coincidentally, Eskew et al. (2009) note the results from their study strongly matched ontogenetic shifts seen in an Oregon population of *Thamnophis atratus hydrophilus*. In the Williams et al. (2004) studies of *Thamnophis*, it was noted how birds are heavy predators of snakes in wetlands. *Agkistrodon piscivorus* is a substantially larger snake than any *Thamnophis* species, so it would be reasonable to suggest that if they are able to sequester toxins from their diet of toxic salamanders, juveniles would benefit more from being poisonous to smaller predators like birds than would large adults, so this ontogenetic dietary shift might not only provide evidence that juvenile cottonmouths are poisonous to their predators, but they are also more poisonous than the adults.

Consistent with the bright coloration of highly poisonous populations of *Thamnophis*, *A. piscivorus* is the only species of *Agkistrodon* to exhibit a substantial morphological color change from bright juvenile colors to drab and more cryptic coloration in adult life. Juvenile *A. piscivorus* have also been found to undergo ontogenetic change in regard to their use of threat displays (Glaudas et al., 2006). Glaudas et al. (2006) show how threat response is ontogenetic in *A. piscivorus*, and while they showed their predicted significance with adults reducing strikes after repeated exposure compared to juveniles, it should be recognized that tail shaking and mouth gaping were consistently much higher in juveniles than in adults (see Glaudas et al., 2006: Figure 1). It should also be noted that mouth gaping is to display the bright white inside to attract attention, and should not be confused with showing teeth which would be associated with biting or venom (Glaudas et al., 2006). While correlations should always be regarded speculatively as causation, aposematic coloration and defensive postures are unifying characteristics of poisonous snake populations both possessing and lacking nuchal glands. This population of *A. piscivorus* also exhibits higher levels of toxic amphibian diet than some other populations (Himes, 2003; Savitzky, 1992), which is consistent with *Thamnophis* trends showing regional variation in diet variety and the level of toxin resistance from their prey, and thus the protective effects they sequester from them (Feldman et al., 2010). This is, of course, speculative as to which ontogenetic dietary changes, threat displays, or color changes occurred first, but it is an area which appears lacking in research.

Perhaps the most likely candidate for a snake that is poisonous to its potential threats is *Liophis epinephelus*. *Liophis* is a genus of colubrid snakes in the subfamily Xenodontinae, a group also known for specializing on anurans. *Liophis* (as *Leimadophis*) *epinephelus* is the only known predator of *Phyllobates terribilis*, the most toxic documented land vertebrate (Myers et al., 1978). Since its description in 1862, this species has been moved repeatedly between the genera *Liophis*, *Leimadophis*, *Erythrolamprus* and *Opheomorphus*. Extensive searches of literature encompassing all species in these genera yielded no studies which tested possible dietary sequestering of the highly toxic components of their *Phyllobates* prey. Many studies, such as Krynak (2011), recognized the ability to consume these toxins, but testing of organs, tissues, blood, and skin appears to so far be an untouched area of research to see if this species is granted an evolutionary benefit to sequestering these toxins, or if they are participating in a similar evolutionary arms race as observed between *Thamnophis sirtalis* and *Taricha granulosa*. Due to the incredibly high potency of *P. terribilis*, and the fact that *L. epinephelus* is its only known predator, the latter seems quite likely to be occurring. Studies using different sizes of *P. terribilis* and frogs that have had a captive diet of crickets for seven months, which is estimated to reduce the frogs' toxicity by 50%, do show consuming these toxins is not completely without ill effect (Myers et al., 1978), indicating at this point in time the frogs might be slightly in the lead if such an arms race exists. However, LD_{50} tests on mice indicated the batrachotoxins found in *P. terribilis* were lethal to small mammals at 2.5 μg/kg, which is nearly 20 times the toxicity of TTX to birds, and some limited tests suggested larger mammals to be even more sensitive than small mammals to the toxins (Myers et al., 1978). It would seem rather unwise for any animal to be preying on *L. epinephelus* if there is a chance it has recently consumed a *P. terribilis* of any size (Myers et al., 1978). *Liophis epinephelus* also has a bright reddish-orange nuchal region, particularly noticeable in juveniles, that is remarkably similar to that seen in *Rhabdophis*, and is consistent with the aposematic trends seen in all four genera of currently documented poisonous snakes.

It is, of course, not impossible that none of the snakes here suggested for examination have any capabilities of sequestering the toxins they are consuming in their amphibian-rich diet, and that these pass through their systems at such a rapid rate they offer no risk to potential predators of the snakes. However, the

levels of TTX seen in *Thamnophis* a month after it eats just one newt suggest that is likely not the case, unless all species mentioned have livers with particularly impressive turnover rates, or *Thamnophis* livers have a particularly unimpressive rate relative to other anurophagous squamates, which would also be an anomaly worthy of investigating if it were the case.

Despite that *Macropisthodon* and *Balanophis* were documented to have poisonous nuchal glands nearly 50 years prior by Smith (1938), Williams et al. (2004) cite Akizawa et al. (1985) in their paper on poison sequestering in *Thamnophis*, when making the claim that *Rhabdophis* is the "only" documented poisonous snake. Inaccurate statements like this in peer-reviewed literature further support that poisonous snakes are indeed a poorly understood and under-researched topic.

Many of the above-mentioned poisonous and potentially poisonous snakes show an intricate relationship in the evolution of both top-down and bottom-up eco-effects (Williams, 2013). Snakes are in a race to withstand the toxins of their prey, which in turn leads to their prey becoming more toxic (Williams et al., 2003). They are also enduring a race with their predators by using consumed toxins to develop new defense strategies for themselves and their offspring (Hutchinson et al., 2013). It is still unconfirmed whether snakes acquiring toxins from amphibians are able to increase the potency of their poisons by hydrolyzing side chains as seen in dendrobatid frogs (Hutchinson et al., 2007), but if further research supports this, the role of poisonous snakes in an ecosystem could be greatly expanded, and there might be medicinal uses (Clark, 1997). In the end, much of this fate sits on the shoulders of the prey that are the source of these toxins. Amphibians currently face a multitude of threats, not limited to climate change, emerging diseases, and pollution (Rodrigues et al., 2014). Poisonous snakes reveal how losses in amphibian populations can have a larger impact on the ecosystem than previously recognized. A call for more research understanding and identifying these snakes and their intricate niche roles could prove critical in understanding steps necessary to keep many wetland ecosystems in balance.

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Observational Records of Mudpuppies (*Necturus maculosus*) from Some Wisconsin Counties

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Introduction

Casper (1996) provided the most current distribution maps for Wisconsin amphibians and reptiles, along with source references. He added 20 new county records for the mudpuppy (*Necturus maculosus*) to the 29 previously documented by Vogt (1981). Casper (1997, 1999) and Cochran et al. (2002) reported additional records for this species. While undertaking preparations for the mudpuppy species account for a forthcoming book on Wisconsin herptiles, I examined records maintained by the Wisconsin Department of Natural Resources (DNR) and solicited additional reports from fisheries managers and researchers statewide. These efforts confirmed and supplemented numerous county records previously documented with vouchers and yielded observational data from six additional counties. Significant data from these efforts are summarized here to provide a more complete picture of this species' distribution.

Data Sources

I consulted two Wisconsin DNR databases in my assessment of the distribution and conservation status of mudpuppies in Wisconsin. The Natural Heritage Inventory (NHI) includes data on the locations and status of rare species and natural communities and is part of an international network coordinated by NatureServe (www.natureserve.org). Species tracked are those included on the program's working list (http://dnr.wi.gov/topic/NHI/WList.html). The agency's Fishery and Habitat Biology Database serves as the centralized repository for fish propagation information and for all fish and stream habitat survey results. Agency staff members access the database through a secure internet site, but fish stocking summaries are available to the public (http://dnr.wi.gov/topic/fishing/stocking/). Both databases include information on mudpuppies. The NHI database also includes occurrence data for the state threatened salamander mussel (*Simpsonaias ambigua*), an obligate parasite of mudpuppies, that can provide insights into mudpuppy distribution.

In addition to the database reviews, I emailed a request for observations to all Wisconsin DNR fisheries management and research personnel in early March 2015. To date, the request has yielded more than 40 responses with considerable biological information, including observations in several counties where mudpuppies were previously unreported or poorly documented.

Observational Records

Adams County—The NHI database includes a single unpublished record. Former Wisconsin DNR chief park naturalist George J. Knudson reported observing a mudpuppy that had been caught by an angler just below Castle Rock Dam on the Wisconsin River (43.86 N, 89.72 W) on 22 April 1961. Previous records from across the river in Juneau County and downstream in Sauk County exist, and Vogt (1981) reported an unvouchered record from elsewhere in this county.

Crawford County—The NHI database includes records of mudpuppies caught in the nets of commercial fishermen at the mouth of Garnet Lake (43.01 N, 91.15 W) near the Mississippi River on 15 June and 7 July 1996. These records supplement a report made by Cochran and Lyons (1986) of a mudpuppy being caught in a hoop net a short distance away on the Wisconsin River. This latter record was not included in Casper (1996), presumably because it was not vouchered.

Iron County—Casper (1997) documented the first record from this county based on a photograph, but even though he provided township and range information, it is unclear what waterbody his specimen came from. The NHI database includes a record of two photographs of mudpuppies taken by Jim (Julio) Zarzycki on Trude Lake (46.20 N, 90.14 W) in September 1994. These are presumably the source for Casper's (1997) record. To this record, we can add Owl Lake (46.27 N, 89.97 W) and the Tyler Forks River (46.26 N, 90.48 W) where fisheries surveys were conducted in September 2003 and August 2014, respectively. Mudpuppies were observed or collected during both surveys.

Langlade County—Fisheries biologist David Seibel and his crew conducted a baseline monitoring survey on Mueller Lake (45.16 N, 88.98 W) on 30 April 2012. They observed two mudpuppies at one sampling station and 14–15 more at a second in the lake.

Oconto County—Fisheries biologist Tammy Paoli and her crew sampled with fyke nets at ten sites on the Leigh Flowage (45.04 N, 88.23 W) between 08 April and 16 April 2015. They collected a total of 39 mudpuppies at nine of their sampling sites.

Price County—Mudpuppies are known from Price County from a single specimen housed in the Illinois Natural History Survey collection (Casper, 1996). Results from a number of fisheries surveys provide a more complete picture of its distribution in this county. Mudpuppies were collected or observed during surveys in Round Lake (45.92 N, 90.06 W) in October 1994, Deer Lake (45.72 N, 90.41 W), Duroy Lake (45.69 N, 90.38 W) and Solberg Lake (45.75 N, 90.37 W) in spring 2000, Wilson Lake (45.67 N, 90.45 W) in April 2002, and the North Fork Jump River (45.43 N, 90.61 W) in August 2007. The NHI database also includes a report of two mudpuppies taken with a fyke net on Long Lake (45.70 N, 90.40 W) in May 1993.

Rusk County—Wisconsin DNR fisheries managers conducted a fisheries assessment survey on Amacoy Lake (45.4 N, 91.31 W) on 02 May 2000. They found a single mudpuppy at one sampling station. A similar survey was conducted on the Little Jump River (45.31 N, 90.98 W) on 11 August 2008, where a single mudpuppy was noted. During an assessment of the Thornapple Flowage (45.41 N, 91.19 W) on 14 April 2009, a single mudpuppy turned up in one of the survey nets. In addition, wildlife technician Christian Cold reported mudpuppies as being common on the Flambeau and Chippewa rivers in August 1994. These records supplement the photographic record provided by

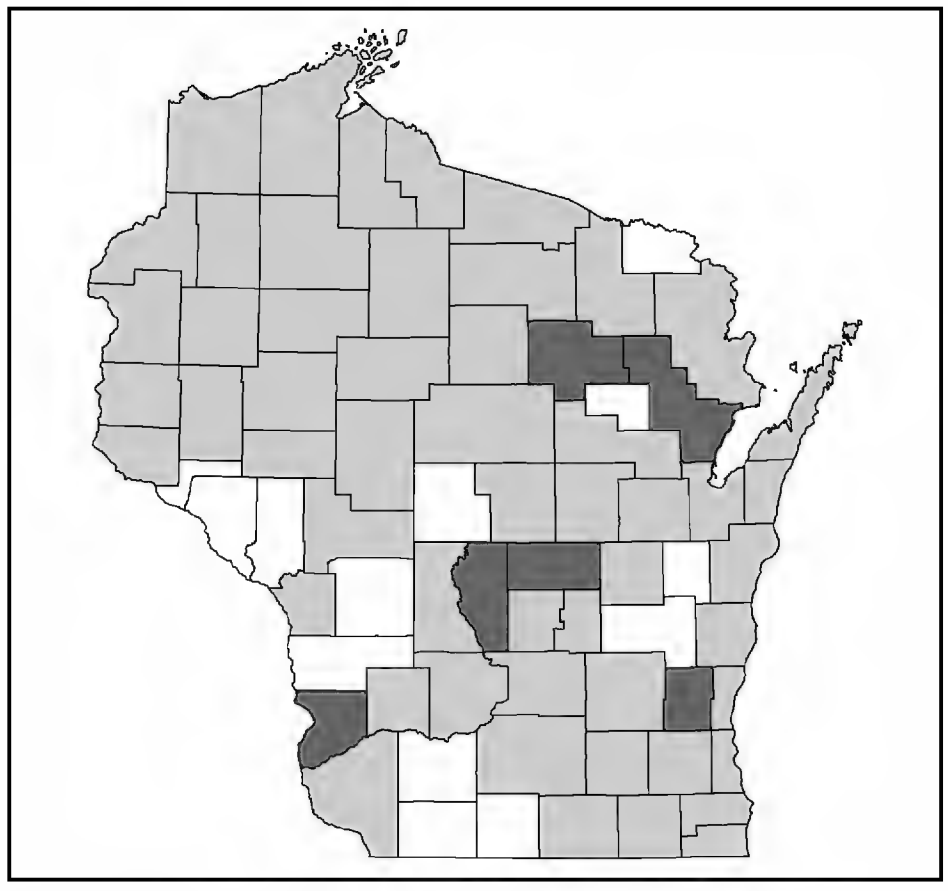

Figure 1. Distribution of mudpuppies in Wisconsin. Lighter gray shading = vouchered records (references in text); darker gray shading = new county records based on observations reported in this paper.

Casper (1997). The recent presence of the salamander mussel in stretches of these latter rivers further confirms the anecdotal observations of mudpuppies in this region of the state.

Taylor County—Mudpuppies are known from Taylor County from a single specimen housed in the University of Wisconsin-Stevens Point collection (Casper, 1996). Results from the fish distribution survey conducted in September 1977 (Fago, 1983) and a fisheries assessment conducted in September 2000 confirm its presence in the Black River (45.14 N, 90.36 W; 45.23 N, 90.33 W), the county's predominant river system. The recent presence of the salamander mussel in the Black River (L. Kitchell, Wisconsin DNR, pers. comm.) also suggests the mudpuppy's presence.

Washington County—The NHI database included two records of mudpuppies in Pike Lake (43.31 N, 88.32 W). Fisheries biologist Jon Nelson reported many mudpuppies present in this lake in 1992, and in December 1995, conservation warden Robert Lee noted "I see many mudpuppies lying on the ice of Pike Lake. They are caught by fishermen and then thrown onto the ice." Fisheries biologist Travis Motl also reported collecting mudpuppies in Silver Lake (43.23 N, 88.13 W) during fisheries surveys in April 2015. Neither Vogt (1981) nor Casper (1996) included records from Washington County, but Pentecost and Vogt's (1976) distribution map includes a dot record for this county. The observations reported here confirm its presence.

Waushara County—Fisheries technician Scott Bunde noted mudpuppies as being common during survey work he conducted on Long Lake (44.21 N, 89.12 W) and suggested they might have been more abundant in 2014 than in 2005 and 2009.

Value of the Data

Mudpuppies occur essentially statewide in Wisconsin, now having been reported from 59 of the 72 counties. The above records fill significant gaps in the species' known distribution (Figure 1). When considered alongside museum records, these unvouchered but reliable data provide a more complete picture of the distribution and status of this species; the observational records both confirm and expand the available information.

Although conservation agency data like these are generally "public records," such data often remain unpublished and, as a result, largely unavailable to the broader scientific community. Investigators working to understand the distribution and status of species can benefit from contacts with resource managers and conservation agency staff who often have ready access to unpublished information. Resource management personnel can build broader support for their efforts by making their data more widely available to those with an interest in conservation.

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The Cyclops Bags Some Bunnies

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When this author relocated to Arizona in May of 1981, he did so with dreams of finding several species of cool herps in the wild. The top three species on his life list were Gila Monsters (*Heloderma suspectum*), Ridge-nosed Rattlesnakes (*Crotalus willardi*), and Mountain Kingsnakes (*Lampropeltis pyromelana*). These three species were so high on his list that there was no first, second or third place with them. They were *all* coveted equally, and all measured the same on his personal life list Richter Scale. If he were to rank herp species on a personal scale of one-to-ten, all three were elevens.

All three species came my way—eventually. But it was not until May of 1989, eight years after arriving here, that I had personally found the big three. One fine day, this author may use this forum to describe the effort that went into finding each of them. The elation that followed each event lasted for months.

Connections with people of herpetological bent here was very slow developing. But thanks mainly to the formation of the Tucson Herpetological Society in 1988, I was able to find people who shared my passion. In 1989, I purchased my first notebook, and began to document each field trip, the people who were with me, and what we were finding. That practice continues to this very day. Eventually, my penchant for taking copious field notes and documenting what was being observed caught the eye of a noted serpent guru, Dr. Gordon Schuett. (For that, I can thank Mike Dloogatch, our esteemed editor). In the early goings of 2001, Gordon proposed that we do a radio-telemetry study on Western Diamond-backed Rattlesnakes (*Crotalus atrox*). We selected a remote mountain range around 50 miles north of Tucson as our study plot. The area was chosen by both Gordon and this author because it had several aggregate dens of *C. atrox*, has easy access, is scenically appealing, and has terrain that allows for some fairly easy footwork.

On 9 March 2001, we officially began the study. But oddly enough, we began it with a Gila Monster! How that happened is a long story, which shall be saved for some other day. To say that I was excited at being able to follow a Gila Monster around is an understatement. I was living a dream.

Our study is just now winding down, 14 plus years later. It has been the longest continuous multi-species venomous reptile radio-telemetry study on the same patch of ground in the history of Arizona. In addition to radio-tracking 18 Gila Monsters, we also tracked numerous *C. atrox*, Black-tailed Rattlesnakes (*Crotalus molossus*), Tiger Rattlesnakes (*Crotalus tigris*) and a Mojave Rattlesnake (*Crotalus scutulatus*).

As one might guess, the dataset that accumulates over the course of a long-term study like this is downright formidable (see Figure 1). One must keep in mind that every time an animal's radio signal is tracked to its source, that is the ground it is on or under; that animal is nailed with scientific certainty nine ways to Sunday. There is no guesswork involved, just a recording of facts. If the animal is visible, photographs are also taken. Each datasheet can contain up to five entries, and five tracking episodes can take an entire morning or evening to accomplish. As the good Doctor Schuett is fond of saying, each data sheet that is added to our three-ring binders is a like a grain of sand on a termite mound. It all takes a long time to accumulate, but as time passes, the results are piled high.

Sometimes, just one entry, one fifth of a page, is more than enough to fill a monthly column for the Chicago Herpetological Society *Bulletin*. And I'm quite sure that any reader who slugs their way through the remainder of this column will say "He's right! That was more than enough!"

Heloderma suspectum number 13, or Hs13 for short, volunteered to be one of our subjects on 24 May 2008 at 0846 hours. She volunteered in the usual way, by being witlessly out on open ground, directly in the path that two equally witless humans of scientific bent were blundering forward upon (Figure 2). During the process of photographing every angle of her body, it was noted that her right eye seemed to be welded shut (Figure 3). Hence, we immediately named her Cyclops, which is a most un-ladylike name. But we are talking about a Gila Monster, are we not?

And now, we must take pause in the narrative to deal with those who might take a dim view of those who name their subjects in a scientific study. They might even ask "What kind of bunny foo foo crap is this? They name their subjects? How cute, how quaint!"

In response to this kind of thinking, my father had four sons. The third one was named Roger. Even though there were only four names for the poor guy to remember, he never got my name

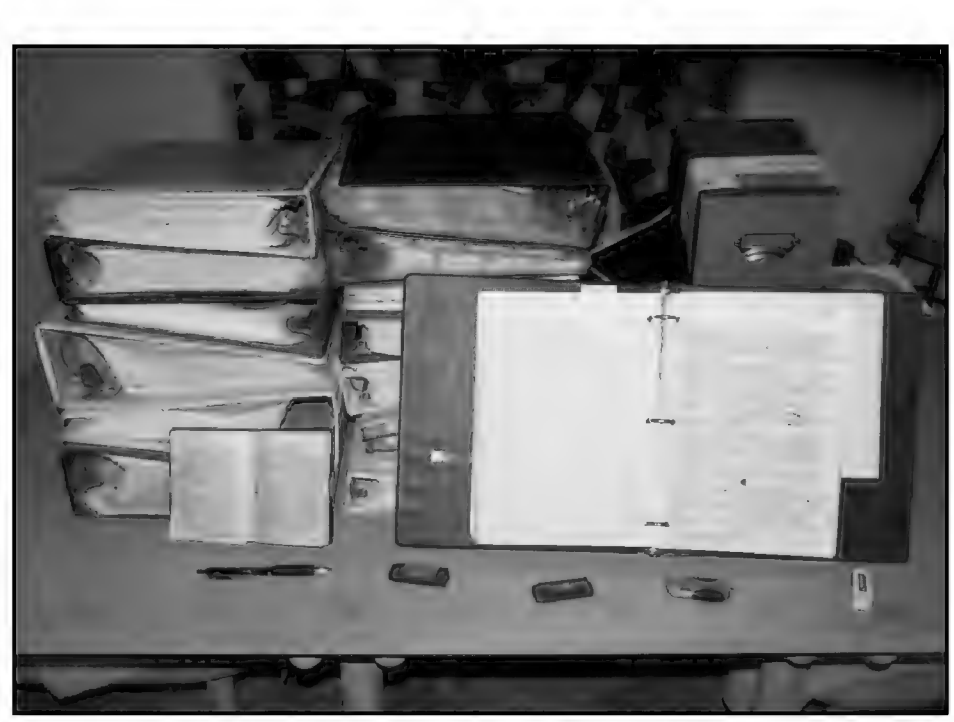

Figure 1. An accumulation of raw data from the Suizo Mountain Project dating back to 2001, and additional field notes of the author going back to 1989. Scattered in the foreground are various relics of electronic data storage, and a pen that was deliberately placed in the image. It is interesting to note that we have lost 50% of our data (mostly digital images) due to computer mishaps. We have never lost a single page of data done performed by the conventional method of ink and paper. Exact photocopies of all data exist in a separate location, in hopes of assuring that raw data is *never* lost.

Figure 2. *Heloderma suspectum* #13, (Hs13), moments prior to capture, 24 May 2008.

Figure 3. Right side of head of head of Hs13 post capture. Note the sealed right eye on this subject, which earned her the nickname Cyclops.

right the first time when addressing me. When speaking to me, he simply called me all four names: "Dan, Bob, Ron, Roger—get me a beer." That way, in his mind, he covered all four bases, and was never wrong. Were I to remonstrate by whining about getting him a beer, and suggest that perhaps he should get his own beer (which was always a mistake), my name was always "Dammit! I said get me a beer!" For a very long time, I was not sure whether my name was "Roger," "Dan, Bob, Ron, Roger," or "Dammit!"

Now think of two people trying to keep track of up to 37 animals at one time. I might mention to Gordon: "Hs13 did this or that yesterday." He would reply "Uh, refresh my memory. Which one is that again?" I would reply "Cyclops," and then we would both mentally be on the same page. We had 37 children to keep track of! At least sometimes, when numbers don't work, names do!

And as the rest of this narrative might indicate, we are most certainly not the bunny foo foo type.

Our friend and colleague Dr. Dale DeNardo performed the transmitter implant surgery on Cyclops. Upon noting the condition of her right eye, he smeared some salve on it, and gently unsealed the eye by running the wooden end of a cotton swab along the length of the eyelid seam. This simple fix worked wonders, as both of her eyes seemed to function again for the remainder of her tenure with the study. Cyclops was no longer a cyclops, but the name stuck.

Upon her release, Cyclops behaved just like a normal wild Gila Monster. We never saw her! It was like tracking a Russian nuclear submarine—she was never visible. What followed her release was just a bunch of write-ups that went something like

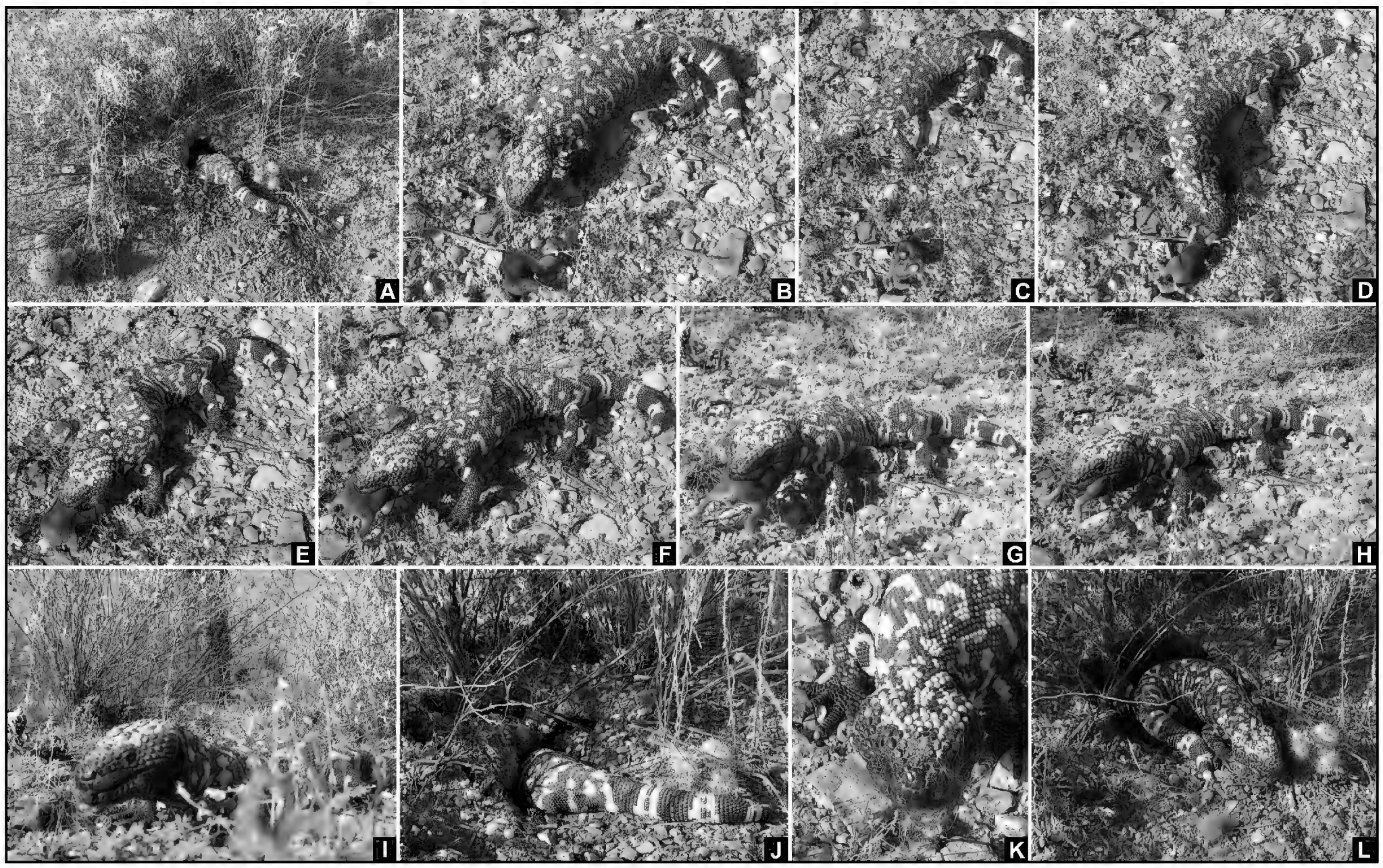

Figure 4A to 4L. Abbreviated photographic sequence of the observation described in this column. Refer to text for details. All images by the author.

"Not visible, packrat midden," or "Not visible, soil holes under prickly pear cactus." At one point, she threw us a change-up by being not visible in an old badger hole. In short, she was about as exciting as watching wet paint dry. This is to be expected when radio-tracking an animal that spends a large portion of her life underground.

That all changed on 9 August 2008. I had just finished the write up on a Tiger Rattlesnake, and was considering pulling the plug on both the receiver, and the morning. It was getting hot! As I was in the vicinity of where Cyclops was last tracked, her signal was dialed in. The signal indicated that she was indeed within striking range, so off I went to mow her down. And for once, the extra effort paid off.

I spotted her at a distance of over 30 meters. Her flaming orange and black rear haunches stood out like goat turds in the milking pail on the open ground they were occupying. The front half of her body was thrust into the opening of a soil hole that was roughly double the diameter of her flanks. The hole was at the base of two bursage, some pincushion cactus were peppered about her to either side, and a burgeoning crop of spurge was scattered helter-skelter all around. A small mound of loose dirt was beneath and beside her, she was obviously bulldozing her way into the hole, widening it with her front claws (Figure 4A). As soon as this was observed, the receiver was shut down. Once the crackling static was eliminated, the faint sounds of mewings were heard emanating from the hole. Hot-**diggity**-damn, and raise my rent! I was witnessing a predation event with a wild Gila Monster! These are scarcer than a virgin in a maternity ward, and at least in my own mind, the pure serendipitous luck of it raised me to the level of the greatest monster masters to ever walk the face of this planet! For once, **finally**, I was in the right place at the right time!

And then the question popped into my mind: "Now what do I do?" I was like the proverbial dog who has finally caught the car, and doesn't know what to do with it. It certainly all started well. The receiver was turned back on, the stopwatch applied, and the next two minutes were spent counting eleven blips twice. Said blips were counted to within 2/100ths of a second of each other. These blips, coming from a temperature-sensitive radio transmitter, told me that her body temperature was 35.5 degrees Centigrade (95 F). One fine day, the whole world (or at least two people interested enough) would know with certainty the body temperature, at this exact moment in time and space, of an ectothermic predator consuming a meal—or at least trying. My next moves weren't all bad either. Turn the receiver off, unplug the antenna, temporarily forget the data—and go for the camera. The camera was unzipped from the omnipresent pouch at my right side, and two quick in situ images were snapped. But when it came time for the money shot, there wasn't one to be had. A flashlight was applied, as was my mirror, but it was absolutely impossible to get the light around the hulking backside of the Cyclops to even see—let alone photograph—what was going down inside that hole. It was time to improvise! With the camera still in my left hand, I clamped the tail of Cyclops in my right, whisked her out of the hole, and stood up straight. Oops! It quickly became apparent that our monster had a furry little hopper Desert Cottontail Rabbit (*Sylvilagus audubonii*) by the scruff of its neck in her jowls, dangling 1.2 meters above the ground. The mewings of the hapless thing, which heretofore had been muffled by the poor acoustics inside the hole, grew instantly louder upon the abrupt egress caused by my lawnmower-starting-like tug on the monster's tail. What came next was predictable. Cyclops dropped her meal, and it plopped to the ground with an audible thud. This action caused the hopper's scream to increase in volume and intensity. "MEW-MEW-MEW-MEW-MEW . . . . . " As it twitched in circles on the ground, it was noted that the skin had been broken where Cyclops had snagged it in her jowls, the wound covering the entire neck scruff. This would imply that in this case, the prey item had been envenomated. "MEW-MEW-MEW-MEW" screamed the prey item, and kept screaming it until I tell the reader that it stopped. It was impressive in duration, shrill, and nearly earsplitting in volume.

Within a split second after Cyclops dropped the little hopper, I gently laid her on the ground in such a fashion that her head was inches away from it, aiming right toward it. (Figure 4B). Time stood still for a few seconds. The rabbit was gyrating in front of Cyclops, still raising quite a fuss, and Cyclops seemed quite interested. The next question was "Will Cyclops succumb to her predatory lust and consume the prey item, or had my interruption wrecked this observation, not to mention a potential meal, beyond all hope?"

Meanwhile, right or wrong, whenever I'm in for the dime, the dollar follows shortly thereafter. With the faceoff of predator and prey directly in front of me, I took a knee, flipped the LCD screen out of my camera (which was still in my left hand), and twisted the screen to the perfect angle. I could watch whatever transpired next through both the screen and the naked eye. I then began snapping images. There was no reckless, rapid fire shooting going on. Each shot was carefully timed at about ten second intervals. "MEW-MEW-MEW-MEW" screamed the rabbit, "Gawd this is **awful**," thought the photographer.

Cyclops stared at the little bunny that was writhing inches from her snout. She turned, as if to walk away from it all. I groaned inwardly (Figure 4C). Hapless bunny continued its epic dialogue: "MEW-MEW-MEW-MEW" some more. Cyclops turned to leave again, but once again, swung back to face the verminous little noisemaker. Suddenly, she lunged forward, and her jowls completely engulfed the head of her prey item. Chomp! Muffled "meef-meef-meef-meef" said the rabbit (Figure 4D).

There were two slight head adjustments on the part of Cyclops. Both times, she nearly spat the morsel out, but each time, she woofed it back in. The second adjustment seemed to line everything up just right, and down the hatch it went (Figures 4E through 4I). The mewings continued to the point where just the pink little bunny feet were left protruding, but they audibly diminished in the wake of the organic Doppler effect that being swallowed alive creates. As those tiny pink feet disappeared down the gullet of Cylops, she bobbed her head upward, back down, and then up again. Her body kinked from left to right with serpentine motions, and all got quiet. There next followed a wide gape, and the forked black tongue completely lapped the perimeter of her lips. It was likely her way of saying "Yummy!" "Now," thought the photographer, "are you going to back for

more, or are you done?" As if in response to the question, the black tongue began to flicker about in earnest. The wavering tongue seemed drawn toward the direction of the hole, as if some magnetic force was pulling it in that direction. Cyclops raised her body off the ground, and briskly ambled a distance of about a meter, plunging headlong into the hole without hesitation (Figure 4J). An instant later, it was déjà vu, as some muffled mewings began to emanate from the hole. She had another one! Hot-**diggity**-damn! No harm, no foul! (And more luck than brains on the part of the fumbling, meddlesome observer).

The time that Cyclops spent choking down her second course was not wasted by the observer. He quietly started emptying his backpack of the usual arsenal of paraphernalia, such as thermometers, a GPS unit, a compass, a datasheet, and a pen. Everything was recorded diligently. Ambient temperature was 29 C (84.2 F), and the ground next to the Gila Café registered 41 C (105.8 F).

What was I missing? Why shoot, I had not yet gotten a mass on any of the baby bunnies! What kind of scientist was I? Out came my trusty Pesola spring scales, which are the epitome of mass measuring devices among the biological community. (Never leave home without one). There was but one minor impediment to applying said Pesola spring scale to a baby bunny. That would be the hulking hindquarters of Cyclops. Once again, I snagged her tail, (déjà vu all over again), but this time dragged her briskly straight out across the ground. But because she was "onto me" now, she was almost on me! She whipped a lightning fast U-turn, and her gaping mouth smacked the knuckles of my right hand broadside. Her strike was totally unexpected, and very close to reaching its mark. Had she cocked her head just a little more inward with her strike, serrated teeth would have sunk into my flesh, and then it would be my turn to scream "MEW-MEW-MEW-MEW!"

Her strike instigated an instant release on my part, and she whirled to face me. Her mouth opened so wide that it seemed it would split her head open, and vigorous head bobs accompanied her lunging form. Her head and face were covered with a thick layer of fur, which added a somewhat comical effect to it all. Was she now a bearded dragon? (Figure 4K). The air was full of her hissing as she advanced on me. She clearly wanted a piece of me! It was decided that a wise course of action might be to use my Whitney snake tongs to pick her up, and gently move her away from the hole so that I could gain access to it. I moved her about four meters away, and she eventually settled down.

All this went for naught. Upon looking shining the hole with my mirror, it appeared empty. Keeping a wary eye on Cyclops, I reached into the nest hole and began cautiously groping around inside. The hole was very shallow, it dead-ended at slightly longer than the length of my hand (~150 mm, or 6 inches). It was lined with grasses and fur, but completely devoid of any bunnies. She had snagged the last one.

Satisfied that the hole was empty, I began to pack up my gear and watch to see what would happen next. Cyclops also wanted her chance at a final nest inspection. She ambled over and plunged back in, remaining inside for several minutes. When she came back out, she curled on top of the nest for a few minutes (Figure 4L). I took this as my cue to leave. I finished packing up, and started to walk away. At a distance of about ten meters, I turned for a last look. By leaving when I did, I missed what was perhaps the best photo opportunity of all. Cyclops was lying straight out of the hole, facing away from it. She gaped mightily three times, licked her lips one last time, and slowly sauntered off. While nobody will ever know the mind of a Gila Monster, my take is that her posturing indicated that she was feeling more like Tarzan than Jane. The knightly pose was triumphant, it was defiant, and it was the epitome of self-satisfaction. I wish that I could share more than just the words to describe it all. I left one damn minute too soon to share an image with the world—but happy was I to at least see it. It's burned in my brain forever. The entire observation lasted from 0820 to 0837—a total of 17 minutes. While I can report with scientific certainty only that she ate two of the rabbits, I strongly speculate that three were consumed during and after my arrival. The first was being devoured upon my arrival, and the second had just begun when I whisked Cyclops out of the nest hole. The third occurred during the time the data was inscribed. While no mass was recorded of the prey items, the size of the young cottontails was comparable to that of a dwarf hamster. I have processed enough such hamsters as a part of our feeding studies to know that 40 grams is a solid estimate.

In the spring of 2012, we pulled all transmitters out of the Gila Monsters on our plot. We did so primarily because they are a lot of work, and their secretive existence makes it nearly impossible to gain any serious insights into the natural history aspects of their lives. The event that was just described was by far the most exciting observation to come from our 11 years of radio-tracking Gila Monsters.

Yes, my arrival in Arizona was done with the hopes that one fine day, I would see a Gila Monster in the wild. Never in my wildest dreams could I have envisioned how slowly it would all develop, and then, how awesome it was to see the pure, passionate, and unadulterated persistence pay off. At this point in time, it has been my privilege to see well over 300 in the wild. And every time a new one turns up, I rejoice as though it will be the last one I ever see. They always serve to remind me how blessed I am to live in Arizona.

This here is Roger Repp, signing off from Southern Arizona, where the turtles are strong, the snakes are handsome, and the lizards are **way** above average.

What You Missed at the July Meeting

John Archer
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Phil Goss has probably done more to protect your hobby than any other person. That's a bold statement and I'm sure that someone is willing to argue with me, but as president of USARK he battles laws and regulations that are gradually eroding your rights to keep not only herps, but also any other animal as a pet. His talk was titled "Us vs. T.H.E.M. (The Anti-pet Agenda)" and he wants you to know who and what threatens your hobby. He'd also appreciate a little help.

Phil Goss. Photograph by Dick Buchholz.

I've known Phil for many years. He's, intelligent, funny, dedicated, hard working, and been involved with nature and animals since growing up in rural Indiana. He is a compassionate and caring pet owner, and he brings that ethic to his duties with USARK (United States Association of Reptile Keepers). For his talk, he delved into the history, fund raising, lobbying, and other aspects of some of the major animal rights organizations. He started by defining the difference between animal rights and animal welfare.

Animal rights groups advocate no interactions between humans and animals that benefit humans and demand total animal liberation. They do not want people to have any pets, wear leather, use animals for any research or for seeing-eye and search and rescue, and wish to abolish zoos. One official of HSUS (Humane Society of the United States), Michael Fox, has stated, "The life of an ant and the life of my child should be accorded equal respect."

Animal welfare organizations are against animal cruelty and suffering and advocate for proper care, husbandry, and humane euthanasia when appropriate. USARK, maintains that pets make our lives better and, Phil added, "puppy breath is awesome."

He presented facts about HSUS drawn from their web site and literature showing that while the organization poses as advocating for animal welfare, little of their huge assets go toward that goal. Less than one percent of their funding goes toward shelters for dogs or cats. Humane societies have been around since the 1800s, but the HSUS was not founded until 1954. When founded they were more animal welfare oriented and about sixty percent of funds went to shelters. For the last decade or so the public face of HSUS has been Wayne Pacelle. Phil had a few quotes from him, such as "We have no problem with the extinction of domestic animals" and "In fact, I don't want to see another dog or cat born." On the web site for HSUS they tell lies such as "Tens of thousands of people get *Salmonella* infections each year from reptiles and amphibians" and "Boa constrictors . . . the most popular in the pet trade . . . have predictably established more invasive populations than any of the other constrictor snakes." They frequently usurp others' efforts and use false statements of their involvement to increase their coffers. The HSUS has no shelters and sends less than one percent of its budget to local shelters.

PETA (People for the Ethical Treatment of Animals) is a group that plainly states their animal rights goals, but they are no less of a threat to keeping any animals. Through sensationalist ads that we've all seen and celebrity connections that they are never too particular about, they raise millions to threaten your rights to love and bond with any animal. PETA operates one shelter in Virginia. In 2014 it saved 39 animals out of 2,626 that went through the shelter. The rest were euthanized.

The ASPCA (American Society for the Prevention of Cruelty to Animals) has moved from a welfare group to an animal rights conglomeration. It operates one shelter in New York City and sends less than three percent of its income to local shelters. Phil showed a list of dozens of other organizations that have also jumped on the animal rights bandwagon because of the vast amount of money involved, over $700,000,000 in 2014. Just the HSUS and the ASPCA took in nearly $1,000,000 per day between the two.

Phil went on to describe even more violent animal rights organizations such as ELF (Earth Liberation Front) and ALF (Animal Liberation Front), groups that resort to vandalism and destruction in support of their causes. Many of the top officials in the major animal rights groups began with involvement in these groups.

Compared to the animal rights groups, the budgets protecting your right to keep a pet are minuscule. PETA had over $50,000,000 in 2014, ASPCA had $166,000,000, and the HSUS had $171,000,000. USARK had $460,000. HSUS brags about pro bono work from over 2,000 lawyers and has over 25 in-house layers. USARK would like to have an in-house lawyer.

The threats are real and continuing. Attempts to pass "Dangerous Wild Animal" laws are ongoing in several states, and laws severely restricting your rights to own certain animals are being put forward in many cities and counties. It only takes one incident or a successful activist movement to set off calls for stricter laws. The animal rights movement is also becoming stronger in Canada and Europe.

So what should you do? Spread the word about these organizations that are not only trying to ban reptiles, but all animals from being cared for as pets. Your neighbor who owns a cat can be educated about the animal rights groups. Get out there and educate people about herps through shows that this society and others may sponsor. Join USARK and spread their alerts and other posts through Facebook and other social media. Donate if you can. Five dollars will make a difference, but join and be informed yourself so that you can correct others' misimpressions. Apathy is surely a losing strategy. Waiting for someone else to do it almost certainly guarantees victory to the opposition. It doesn't take much effort, but it takes some. Do it.

Herpetology 2015

In this column the editorial staff presents short abstracts of herpetological articles we have found of interest. This is not an attempt to summarize all of the research papers being published; it is an attempt to increase the reader's awareness of what herpetologists have been doing and publishing. The editor assumes full responsibility for any errors or misleading statements.

PRAIRIE RATTLESNAKE MICROHABITAT

L. E. Gardiner et al. [2015, J. Herpetology 49(1):131-137] note that prairie rattlesnakes (*Crotalus viridis*) are a species of conservation concern in Canada because of suspected population declines. Data on the habitat selection of prairie rattlesnakes at northern range limits are essential to inform management strategies and implement recovery plans in Canada and other northern regions. The authors used radio-telemetry and generalized linear mixed models to create resource selection functions for Prairie Rattlesnakes (N = 23) in and around Grasslands National Park, Saskatchewan, Canada. Eight habitat variables were compared between used and available sites to quantify microhabitat selection. It was found that prairie rattlesnakes select for specific sites (i.e., within 1 m) with shrub cover and burrows and avoid bare ground. Shrub cover was two-times higher at used sites compared to available ones, while bare ground showed the opposite trend. In addition, two-thirds of all snake location points were within 1 m of a burrow, which suggests that retreat sites are important. None of the habitat variables measured at 10 m from used points were significant predictors of rattlesnake habitat selection, indicating that rattlesnakes select habitat at a very fine level. Northern range limits present a thermally challenging environment in which burrows and shrubs are likely crucial for thermoregulation. In addition, these retreat sites likely provide a prey source, protection from predators, and suitable areas for reproduction. Retreat sites such as burrows and shrubs are therefore critical components of habitat for prairie rattlesnakes and should be included in management strategies for the species.

A TEST OF SUBSTRATE SWEEPING

G. A. Geller [2015, Chelonian Conservation and Biology 14(1):64-72] notes that visible sign produced by nesting turtles has been suggested to be a cue used by foraging raccoons (*Procyon lotor*) to locate nests. Experiments investigating the potential for reducing turtle nest predation by eliminating these surface markings by broom sweeping nesting areas were conducted at 2 *Graptemys* nesting sites along the lower Wisconsin River in Iowa County, Wisconsin, during 2013 and 2014. Ninety-five percent of the natural nests in unswept control areas (n = 20) and all of the nests in swept treatment areas (n = 16) were depredated by raccoons within 24 hrs. Supplemental artificial nests with refilled manufactured cavities but lacking potential olfactory turtle- or egg-related cues were also excavated by raccoons within similar time lines (97% within 24 hrs) and at high rates both when unswept (100%, n = 20) and when swept (95%, n = 19). However, artificial facsimiles of the surface markings left by nesting turtles, lacking cavities, were disturbed less frequently (26%, n = 19). Findings suggest that broom sweeping was ineffective because the location cues used by raccoons to find newly constructed nests are not primarily visual but olfactory and related to soil profile disturbance, possibly via the microbial metabolite geosmin.

DIET OF THE WESTERN CHICKEN TURTLE

D. T. McKnight et al. [2015, Copeia 2015(2):322-328] note that chicken turtles (*Deirochelys reticularia*) are morphologically adapted for carnivory, and this specialization has been corroborated by diet studies of the eastern and Florida subspecies (*D. r. reticularia* and *D. r. chrysea*, respectively). However, the diet of the western subspecies (*D. r. miaria*) has not been examined. To investigate this important aspect of this subspecies' ecology, the authors collected 54 fecal samples from 22 adult *D. r. miaria* and 13 samples from nine juvenile *D. r. miaria* in southeastern Oklahoma. White River crayfish (*Procambarus acutus*) were found in 88.9% of adult samples (mean of 2.3 crayfish per sample), and appeared to be the dominant food source for adults. There was a significant positive relationship between turtle size and crayfish size, and on average the crayfish were 29.8 mm in carapace length. Insects representing six orders (predominantly Hemiptera and Coleoptera) were found in 57.4% of adult fecal samples. Surprisingly, plants were present in 92.6% of adult fecal samples. While most of the plant matter was unidentifiable, common rush (mostly seeds; *Juncus effusus*), broadleaf cattail (*Typha latifolia*), giant cutgrass (seeds; *Zizaniopsis miliacea*), and purple-fringed riccia (*Ricciocarpus natans*) were identified in several fecal samples. There was a significant difference between the diets of juveniles and adults, with juveniles consuming more insects, fewer crayfish, and fewer plants than adults. These results suggest both that there is an ontogenetic shift in the diet of *D. r. miaria* and that, unlike the other subspecies, *D. r. miaria* is demonstrably omnivorous.

AMPHIBIAN LADDERS FOR ROADSIDE DRAINS

C. McInroy and T. A. Rose [2015, The Herpetological Bulletin (132):15-19] note that roadside drains (called gullypots in the UK) have long been a problem for amphibians and other animals as a source of entrapment and certain death. Where the problem prevails close to migration routes for amphibians, the threat to local populations is significant and can devastate numbers each breeding season. Combined with existing known threats such as road death, road salting, agrichemicals, pollution and habitat damage, the dangers of gullypot entrapment can further imperil local populations to an unsustainable level. In the first UK trial of its kind, this study aimed to mitigate the gullypot problem with the installation of a simple ladder device which can be tailored and retrofitted in all circumstances. The authors adapted a design, tested it in a known problem location and recorded findings. This study aimed to determine if the ladders can be ascended by UK widespread species, demonstrate the effectiveness of the amphibian ladders and quantify the extent of the problem using a robust dataset. The recorded data and observational evidence suggest it is possible to reduce the number of amphibians trapped during the breeding season within road drains by installing amphibian-friendly ladders.

HERPETOFAUNA OF TABUK, SAUDI ARABIA

A. A. Aloufi and Z. S. Amr [2015, Herpetozoa 27(3/4):147-158] report a total of 34 species of amphibians and reptiles from Tabuk Province, Saudi Arabia. These include one species of amphibian and 33 reptiles belonging to 12 families (Chelo-niidae, Gekkonidae, Agamidae, Chamaeleonidae, Lacertidae, Scincidae, Varanidae, Trogonophidae, Boidae, Colubridae, Viperidae and Elapidae). Three species of reptiles are new to the herpetofauna of Saudi Arabia: *Hemidactylus mendiae, Pseudo-trapelus aqabensis* and *Phoenicolacerta kulzeri* ssp. Additional distributional data for the reptiles of the Province of Tabuk expand the known distribution for several Arabian species.

REINTRODUCED JUVENILE ALLIGATOR SNAPPERS

T. Anthony et al. [2015, Chelonian Conservation and Biology 14(1):43-48] note that reintroduction is a common management tool for conserving imperiled species, but many reintroductions have included little or no postrelease assessment of project success. The alligator snapping turtle (*Macrochelys temminckii*) is a long-lived species that has experienced significant declines throughout its range, although suitable habitat remains. The authors report the findings of a reintroduction effort that was initiated in 2008 near the northwestern limit of the species' range, in Oklahoma. Two hundred forty-six *M. temminckii* were released into the Caney River and its tributary, Pond Creek, from 2008 to 2010. All turtles exhibited measurable growth by their first recapture 1–3 yrs after release, and no decline in body condition was observed, either in comparison to prerelease body condition or to the condition of animals in the same cohorts that remained in captivity. Apparent survival and recapture probabilities increased with age. Apparent survivorship values were higher for turtles released in the main channel of the Caney River, but recapture probabilities were higher in its tributary. Ultimately, survivorship values may have been influenced by low recapture rates and emigration, in addition to mortality.

CHYTRID FUNGUS IN AFRICA

E. Greenbaum et al. [2015, The Herpetological Journal 25(2):91-100] note that recent surveys for the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, *Bd*) in Africa have documented the infectious disease in frogs and caecilians from forested habitats in multiple areas of Central and East Africa. The authors tested 166 frogs for the presence of *Bd* from 45 localities representing a diverse array of habitats and elevations (793–2852 m.a.s.l.) in the Albertine Rift (AR) region of eastern Democratic Republic of the Congo during four field seasons, 2008–2011. Fifty-eight of these frogs were positive, for an overall *Bd*-prevalence of 34.9%. Three genera of frogs (*Cal-lixalus*, *Chrysobatrachus* and *Nectophryne*) are reported to be *Bd* positive for the first time. Behavioral observations of *Bd*-positive frogs calling for mates and basking suggest the AR amphibian fauna was not severely affected by chytridiomycosis during the survey. Given the enormous levels of endemism and conservation value of the AR amphibian fauna, additional studies of *Bd* should focus on the region.

GOPHERSNAKE DENS AND NESTING SITES

K. E. Williams et al. [2015, J. Herpetology 49(2):207-216] note that northern range limits for snakes may result from thermal constraints, especially for oviposition and hibernation. They characterized hibernation and oviposition sites for federally threatened Great Basin gophersnakes (*Pituophis catenifer deserticola*) near the edge of their northern range limit in south central British Columbia, Canada. During 2006 and 2007, most gophersnakes (75.8%) hibernated alone. At a more northern study area, typical hibernation sites were in grassy hillsides, whereas at southern study areas snakes hibernated in rocky outcrops. All snakes that denned in rock outcrops reused sites over years, but only 28.6% of snakes that hibernated in rodent burrows reused sites. Most female gophersnakes (94%) laid eggs in sites that were not used by other females, and reuse of sites was rare (12.5%). Almost all of the oviposition sites were in grassy slopes, with any shrubs and trees more than 5 m away; females selected grassy or sage-steppe cover for oviposition. This pattern of mostly individual and single-use hibernation and oviposition sites suggests that hibernation and oviposition sites are readily available as components of the active-season range within the sage-steppe ecozone, although this habitat is rare and severely threatened within Canada. In terms of species conservation, areas of suitable habitat should be protected based on active-season use, rather than by attempting to find hibernation sites supporting large aggregations of snakes. This recommendation is unlike that for rattlesnakes (*Crotalus* spp.) and gartersnakes (*Thamnophis* spp.), which often congregate at hibernation sites.

SPATIAL ECOLOGY OF FEMALE MAP TURTLES

S. C. Sterrett et al. [2015, Copeia 2015(2):263-271] note that quantifying patterns of habitat use by riverine species is logistically challenging, yet instream habitat characteristics are likely important in explaining the distribution of species. The authors integrated radiotelemetry and sonar habitat mapping to quantify instream habitat use by female Barbour's map turtles (*Grapte-mys barbouri*) in Ichawaynochaway Creek, a tributary to the Flint River. Logistic regression and a Bayesian information-theoretic approach were used to evaluate habitat use relative to habitat availability based on random locations. Over the two-year study period, turtles used an average of 839 ± 199 m of creek length and exhibited site fidelity (mean 50% kernel density = 0.23 ± 0.05 ha). Substrate was generally more predictive of habitat use of female *G. barbouri* compared to large woody debris and water depth. Turtles generally used deeper habitats close to rocky-boulder and rocky-fine substrate with greater amounts of large woody debris. Estimates of home range size and habitat use found in this study improve understanding of the spatial ecology of *G. barbouri* and provide a baseline for their habitat use in a relatively undisturbed section of stream. It is imperative to understand the spatial ecology of species, such as map turtles, that are particularly vulnerable to indirect effects of habitat modifications caused by impoundments, sedimentation, pollution, and snagging.

EUROPEAN TREEFROG CONSERVATION

G. Le Lay et al. [2015, J. Herpetology 49(2):217-221] note that conservation measures to increase or maintain habitat networks in pond-dwelling amphibians often consist of new breeding ponds to supplement existing ones. They examined the effectiveness of this conservation measure in the European treefrog (*Hyla arborea*) by evaluating the speed of colonization and the origin of colonizers using field surveys and genetic methods in an intensively managed agricultural area in Switzerland. One to three years after pond construction, 85 European treefrogs were found at new ponds, and of these, 30 were identified as migrants by genetic assignment tests. A negative correlation was seen between the number of migrants and geographical distance (r = -0.33): 66% of colonizers originated from ponds nearby (up to 500 m); 30% stemmed from source ponds located at distances between 500 and 2,500 m; and 4% originated from distant ponds (2,500 to 5,400 m). Four colonizers crossed a 25-m wide river. These results show that treefrogs rapidly colonize new ponds and that the gene pools at these new ponds contain a wide range of genetic variants of a treefrog population that is patchily structured. Thus, maintaining high pond density is an efficient conservation measure to increase functional connectivity for treefrogs even in an intensely managed agricultural landscape.

ROAD MORTALITY IN CENTRAL BRAZIL

A. M. Souza et al. [2015, The Herpetological Journal 25(3):141-148] note that roads have many detrimental effects on natural habitats and their fauna, ranging from altered microclimate to road kills. Animals which move slowly or are attracted to the road surface are particularly threatened. The authors studied herpetofauna road mortality in a Cerrado ecosystem in central Brazil. They sampled 51 km of state roads during 26 days distributed between dry and wet seasons in 2010 and recorded 109 dead individuals of 34 species of amphibians and reptiles. Including animals found alive on the road, they recorded 159 individuals across 39 species (estimated richness: 48). This number represents about 50% of the herpetofauna species richness expected to occur in a Cerrado site in central Brazil based on a concomitant species inventory. The study indicates that roads can cause high mortality rates for the Cerrado herpetofauna. The authors consider that this problem requires urgent attention since economic growth is largely based on agriculture in the Cerrado and construction of more roads is planned to improve harvest transport.

BEAVERS AND BOREAL FROG COMMUNITIES

M. Vehkaoja and P. Nummi [2015, Herpetozoa 28(1/2):75-87] note that a rapid loss of species and habitats is occurring globally. Amphibians and wetlands are important components of this overall decline. Wetlands in the boreal region are frequently constructed by damming activities of an ecosystem engineer, the beaver (*Castor* sp.). The authors investigated the anuran fauna in ten such "beaver ponds," ten "non-beaver ponds" and eight temporary ponds in Finland. All three anuran species present in the region occupied the beaver ponds, including the moor frog, *Rana arvalis*, a species absent in natural waters (non-beaver ponds and temporary ponds). Moor frogs obviously benefitted from pond construction and removal of trees by beavers leading to a plenitude of shallow water and a wide belt of emergent vegetation. The results show that beavers offer high-quality habitats for anurans and facilitate the occurrence of moor frogs. It is suggested that these ecosystem engineers could be used in ecosystem restoration. The beaver clearly represents a species that promotes amphibian conservation.

EFFECTS OF INCUBATION TEMPERATURE ON HATCHLING VEILED CHAMELEONS

C. J. Ballen et al. [2015, Behaviour 152(10):1307-1324] note that the thermal environment within a reptile nest can affect the phenotypic traits of hatchlings, and hence (potentially) their fitness. Research on this topic needs to measure phenotypic traits relevant to the species involved; and hence, studies on unusual species need to measure unusual traits. The authors investigated the effects of two incubation temperatures on the morphology and behavior of hatchling veiled chameleons (*Chamaeleo calyptratus*). Colder-incubated eggs exhibited a longer incubation period, but produced larger faster-growing hatchlings. Incubation treatment also affected a chameleon's activity level and its unique foraging tactics. Cold-incubated animals were more sedentary, caught prey faster, and extended their tongues farther to reach prey than did their warm-incubated counterparts. Thus, the fitness costs of low temperatures in the nest (slow development, and thus late hatching) may be offset by incubation-derived enhancements in hatchling growth rates and foraging abilities.

The Tympanum

Hey!

Where did you folks get this Roger A. Repp guy who's been contributing articles for the past couple of months? I love his stuff! Please be nice to him and continue to pay him the big bucks he deserves (or the six-pack, or whatever your arrangement is).

By the way, that review of the book about Raymond Ditmars and bushmasters in the last issue by Steve Barten was pretty nice, too. More herp book reviews, please!

Signed,

An anonymous reader

Unofficial Minutes of the CHS Board Meeting, July 17, 2015

President John Archer called the meeting to order at 7:31 P.M. Board members Ed Huether, Aaron LaForge, Teresa Savino and Mike Scott were absent.

Officers' Reports

Rachel Fessler read the minutes of the June 12 board meeting. Andy Malawy read the financial reports. Mike Dloogatch read the list of of expiring memberships. Dick Buchholz reported 37 people in attendance at the June general meeting.

Committee Reports

Upcoming shows:

- Notebaert Nature Museum, first full weekend of each month.
- Green Fair on the Fox, Batavia, August 8, 9 A.M.
- Bug Fest at Red Oak Nature Center, Batavia, August 22, 9 A.M.–2 P.M.
- UnityFest, Marquette Park, Chicago, August 22, 10 A.M.–3 P.M.
- Pet Promenade, Ty Warner Park, Westmont, September 12, 10 A.M.–3 P.M.

Junior herpers: Starting September, the Jr. Herper meetings will run differently. Instead of a main speaker, each month the meeting will be run on a rotation model with four different centers. Three young adults have been recruited to be leaders (Brandon Ottolino, Jarrett Mosely, Onnie Jonas). Each of the leaders will be running a table based on the theme of the month, by giving small lectures on the animals at their table. In addition there will be an activity area led by one of the adult leaders (Colleen, Rich, Frank, Lis) in which the children can participate in a game, song or art activity based on the theme of the month. September's theme: arboreal (carpet pythons, anoles and gargoyle geckos, White's treefrogs). October's theme: camouflage.

The meeting adjourned at 8:34 P.M.

Respectfully submitted by Rachel Fessler

Advertisements

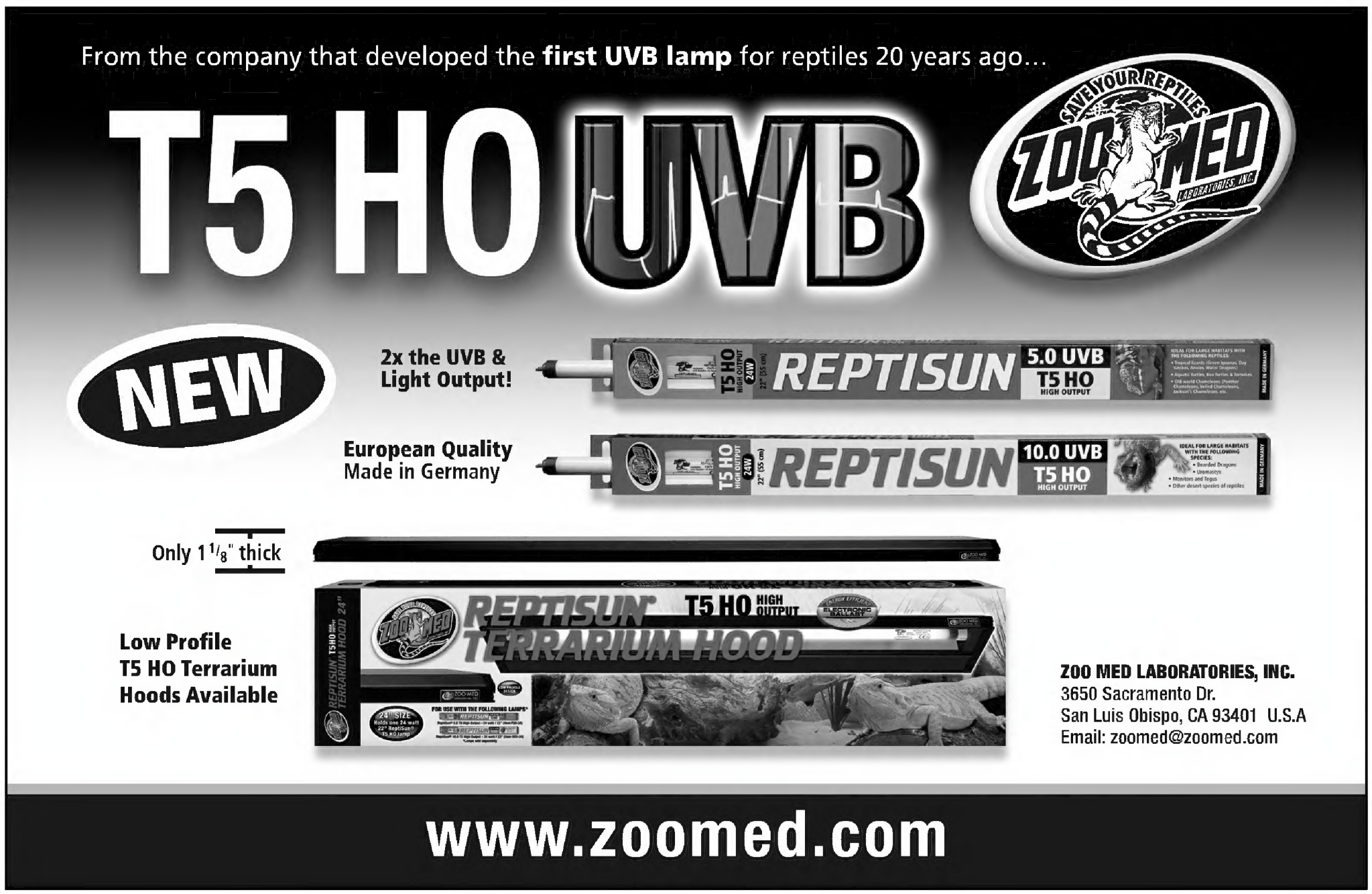
For sale: **highest quality frozen rodents**. I have been raising rodents for over 30 years and can supply you with the highest quality mice available in the U.S. These are always exceptionally clean and healthy with no urine odor or mixed in bedding. I feed these to my own reptile collection exclusively and so make sure they are the best available. All rodents are produced from my personal breeding colony and are fed exceptional high protein, low fat rodent diets; no dog food is ever used. Additionally, all mice are flash frozen and are separate in the bag, not frozen together. I also have ultra low shipping prices to most areas of the U.S. and can beat others shipping prices considerably. I specialize in the smaller mice sizes and currently have the following four sizes available: Small pink mice (1 day old—1 gm) , $25 /100; Large pink mice (4 to 5 days old—2 to 3 gm), $27.50 /100; Small fuzzy mice (7 to 8 days old—5 to 6 gm) , $30/100; Large fuzzy mice / hoppers (10 to 12 days old—8 to 10 gm), $35/100 Contact Kelly Haller at 785-234-3358 or by e-mail at kelhal56@hotmail.com

For sale: Standard 24" Neodesha reptile cages, 3 × 6" vent on top, tempered glass front. Like new condition, no burns or stains, original glass. These cages do not have the dam (horizontal molding that crosses the entire front width of the cage, used to hold back bedding material)—easier to clean without the dam. About 20 currently available, $45 each. Linda Malawy, (630) 717-9955, linda_malawy@hotmail.com.

For sale: High quality, all locally captive-hatched tortoises, all bred and hatched here in the upper Midwest. Baby leopards, Sri Lankan stars, and pancakes usually available, and are all well-started and feeding great! Leopards are $125 ea., Sri Lankans (2012 hatched) $475 ea. And Pancakes are $195 ea. Leopards for out of state sale/shipping require a veterinary health certificate (inquire for cost). E-mail at KKranz1@wi.rr.com or call Jim or Kirsten at 262 654 6303.

Herp tours: **Costa Rica herping adventures**. Join a small group of fellow herpers for 7 herp-filled days. We find all types of herps, mammals, birds and insects, but our target is snakes. We average 52 per trip, and this is our 10th year doing it. If you would like to enjoy finding herps in the wild and sleep in a bed at night with air-conditioning, hot water and only unpack your suitcase once, instead of daily, then this is the place to do it. Go to our web-site http:// hiss-n-things.com and read the highlights of our trips. Read the statistics of each trip and visit the link showing photos of the 40 different species we have found along the way. E-mail at jim.kavney@gmail.com or call Jim Kavney, 305-664-2881.

Line ads in this publication are run free for CHS members—$2 per line for nonmembers. Any ad may be refused at the discretion of the Editor. Submit ads to mdloogatch@chicagoherp.org.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UPCOMING MEETINGS

The next meeting of the Chicago Herpetological Society will be held at 7:30 P.M., Wednesday, August 26, at the Peggy Notebaert Nature Museum, Cannon Drive and Fullerton Parkway, in Chicago. **Dr. Alessandro Catenazzi**, assistant professor of zoology at Southern Illinois University, will speak about "Chytrid Fungus and Its Impact on South America."

At the September 30 meeting, **Dr. Jesús Rivas**, associate professor of biology at New Mexico Highlands University, will speak about his research on anacondas in Venezuela.

The regular monthly meetings of the Chicago Herpetological Society take place at Chicago's newest museum—the **Peggy Notebaert Nature Museum**. This beautiful building is at Fullerton Parkway and Cannon Drive, directly across Fullerton from the Lincoln Park Zoo. Meetings are held the last Wednesday of each month, from 7:30 P.M. through 9:30 P.M. Parking is free on Cannon Drive. A plethora of CTA buses stop nearby.

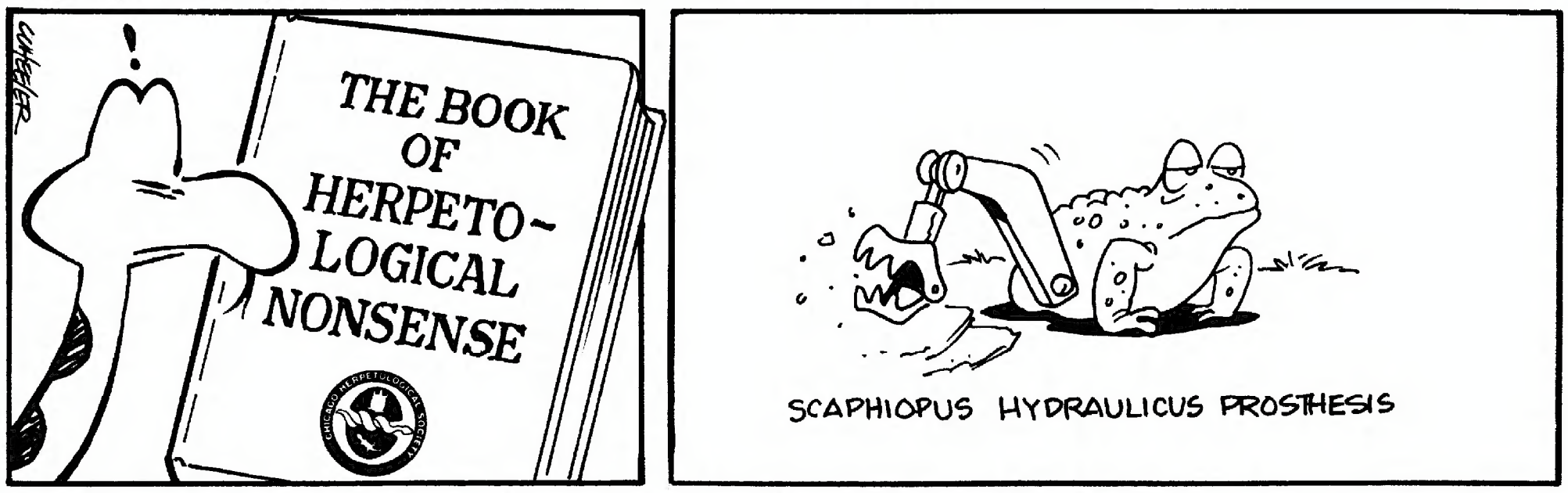
Board of Directors Meeting

Are you interested in how the decisions are made that determine how the Chicago Herpetological Society runs? And would you like to have input into those decisions? If so, mark your calendar for the next board meeting, to be held at 7:30 P.M., Friday, September 18, 2015, at the Schaumburg Township District Library, 130 S. Roselle Road, Schaumburg.

The Chicago Turtle Club

The monthly meetings of the Chicago Turtle Club are informal; questions, children and animals are welcome. Meetings normally take place at the North Park Village Nature Center, 5801 N. Pulaski, in Chicago. Parking is free. For more info visit the group's Facebook page.

THE ADVENTURES OF SPOT



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